Flood Vulnerability and Road Risk in Eastern Oklahoma

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Course: GIS 5653
Term Project Report

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Yes, I am willing to share this project with other students as an example.

Abstract

This project analyzes road segments at risk of flooding across Eastern Oklahoma (commonly known as Green Country). Using open spatial data and geoprocessing techniques, the analysis identifies roads within 100-year flood zones and near major rivers, classifying their flood risk as Low, Moderate, or High. The project was implemented using Python in a modular format with user inputs and interactive options, making it repeatable and flexible. Key components included data clipping, spatial buffering, spatial joins, and classification. The final outputs include shapefiles that can be visualized in ArcGIS Pro, allowing local governments and emergency planners to easily visualize and quantify flood risk to road infrastructure. The workflow is supported by clear scripting, a user-focused main file, and a supporting module containing all major functions. The approach emphasizes automation, replicability, and clarity, with all data processing performed programmatically.

Introduction

Flooding is one of the most frequent and damaging natural disasters in Oklahoma. Transportation infrastructure is often at the forefront of these impacts, as roads serve as critical lifelines during emergencies. This project focuses on identifying road segments within Green Country that are at risk of flooding using publicly available datasets and Python-based geoprocessing automation. The motivation for this project stems from the need for repeatable workflows that local governments and planners can use to prioritize infrastructure resilience. By analyzing roads in proximity to both FEMA-designated flood zones and river systems, this study aims to provide clear, actionable insight into potential vulnerabilities across Eastern Oklahoma counties.

Materials and Methods

Data Sources:

- Floodplain Data: FEMA's National Flood Hazard Layer (NFHL)

- Roads and Rivers: U.S. Census Bureau TIGER/Line shapefiles

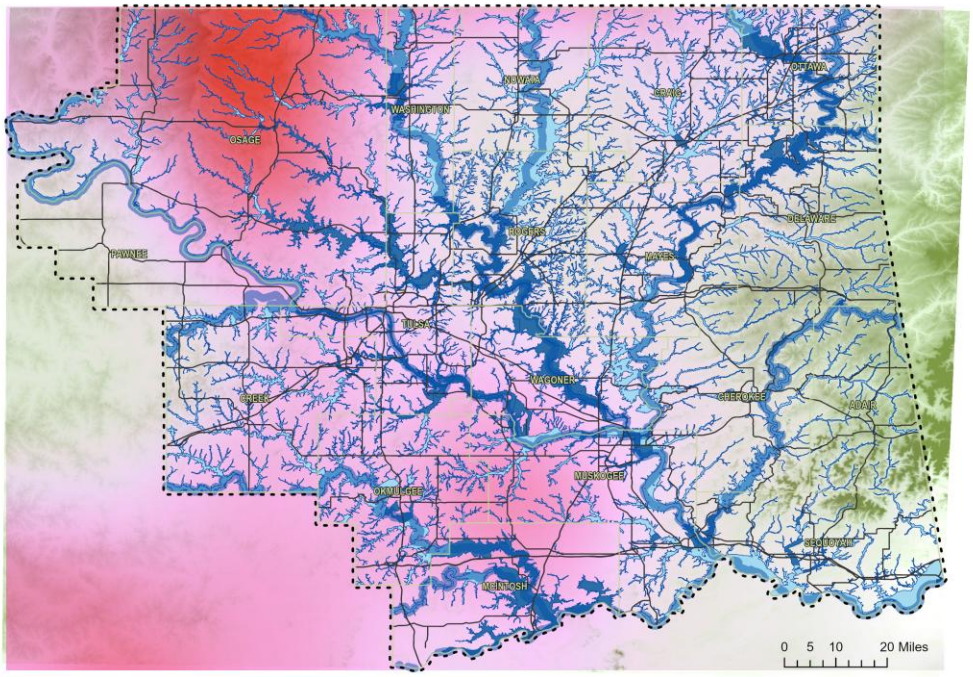
- Rainfall Data: NOAA Atlas 14 (PFDS GIS Grids)

- Elevation (DEM): USGS 1/3 arc-second raster DEM

All datasets were clipped to the Green Country boundary (a set of 20 counties in Eastern Oklahoma). The CRS was standardized to NAD 1983 StatePlane Oklahoma North FIPS 3501 (Meters).

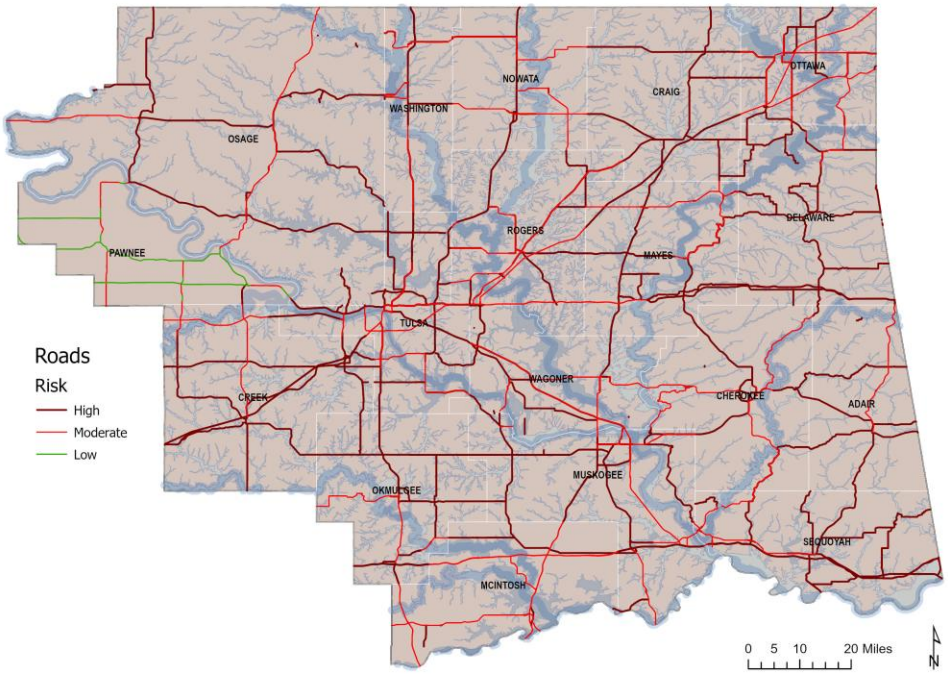
Python Workflow Overview:
- The analysis was written in a standalone Jupyter Notebook using geopandas and shapely.
- The code is split into a main file and a module, with user input (county name) triggering a pipeline of geoprocessing steps.
- The river buffer distance is fixed at 300 feet (≈91.44 meters).

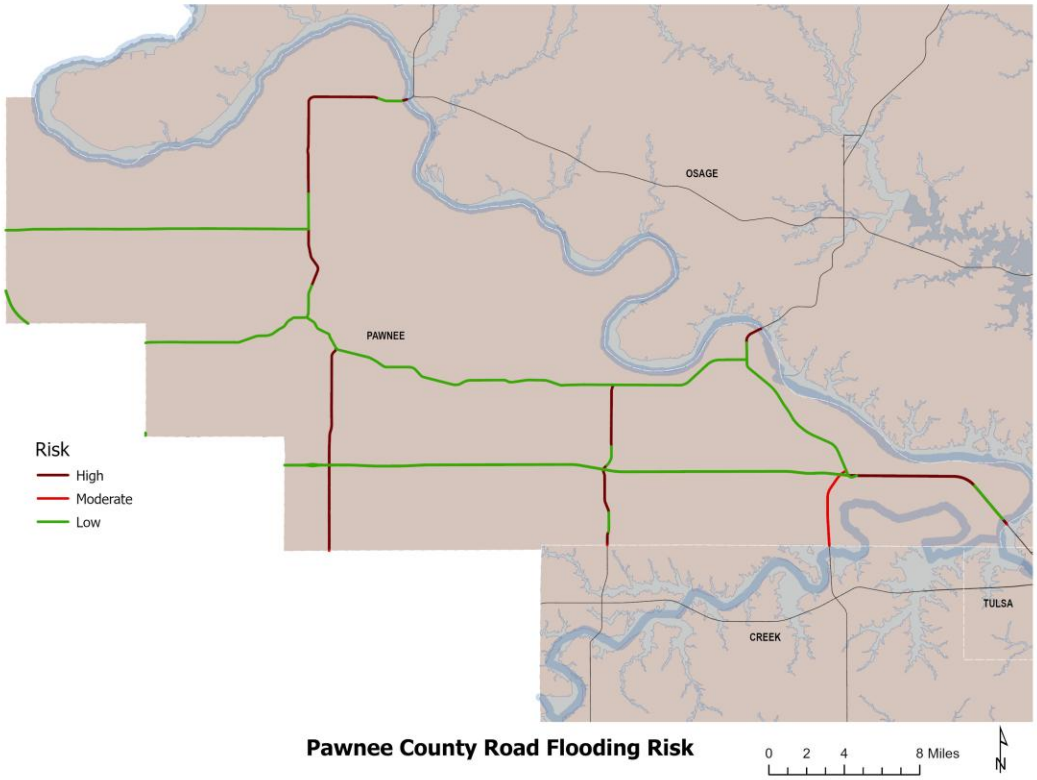
Key Processing Steps:
1. User input: Prompted to enter a county name.
2. Clipping: County-specific clipping of roads, rivers, and floodplain.
3. Buffering: A 300-foot buffer applied to river segments.
4. Classification: Roads classified based on spatial relationship:
   - High: Intersects both floodplain and buffer
   - Moderate: Intersects one of the two
   - Low: Intersects neither
5. Export: Results saved as new shapefile with a Risk_Level field.
6. Summary: Road lengths by risk level output to console.

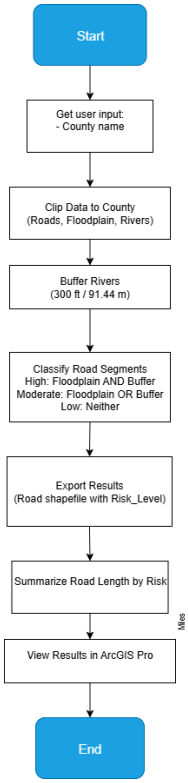


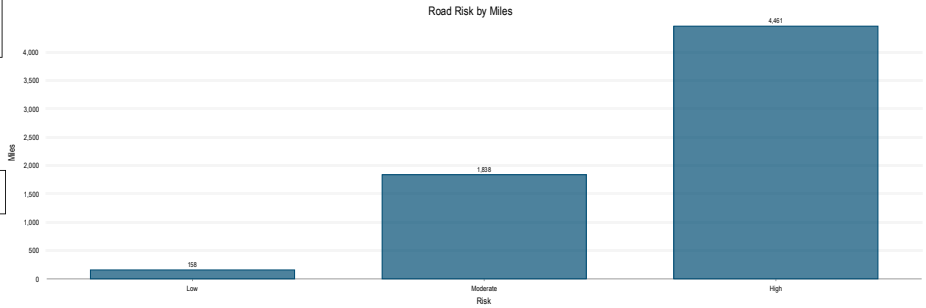
Study Area: Green Country (Eastern Oklahoma)

Study Area
Counties
Roads
Rivers
Floodplain
A
AE
AO
X
Rainfall
High
Low
Elevation
High
Low




OSAGE
PAWNEE
CREEK
TULSA
Risk
High
Moderate
Low
Pawnee County Road Flooding Risk
0 2 4 8 Miles
N


Start
Get user input:
- County name
Clip Data to County
(Roads, Floodplain, Rivers)
Buffer Rivers
(300 ft / 91.44 m)
Classify Road Segments
High: Floodplain AND Buffer
Moderate: Floodplain OR Buffer
Low: Neither
Export Results
(Road shapefile with Risk_Level)
Summarize Road Length by Risk
View Results in ArcGIS Pro
End

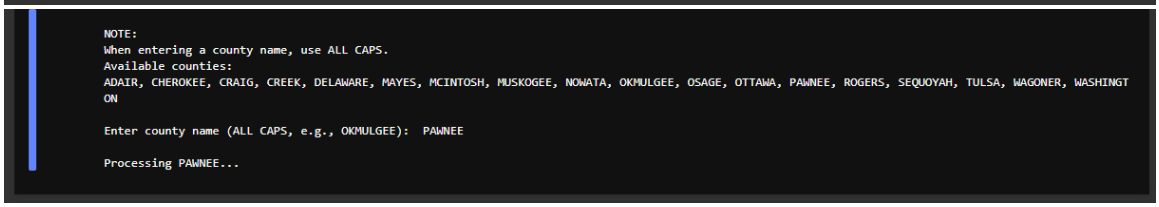

Road Risk by Miles
Miles
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
158
1,838
4,461
Low
Moderate
High
Risk

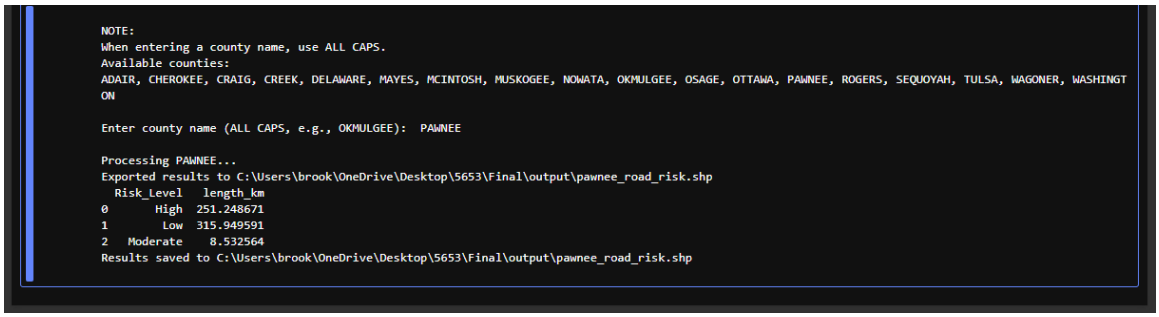
Results

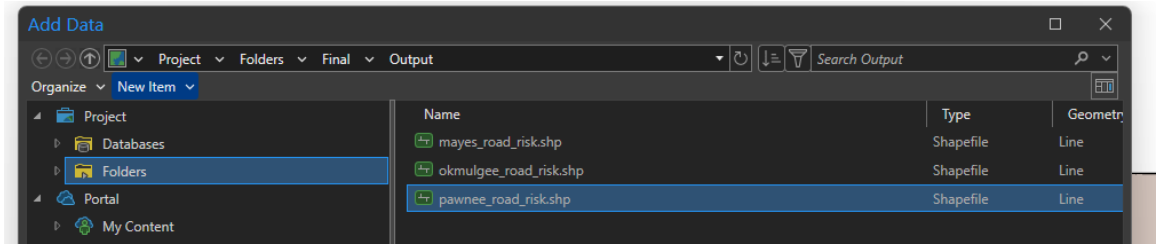
The final outputs include:
- Road shapefiles for each county, labeled with flood risk (High, Moderate, Low)
- A summary of road length by risk
- Maps generated in ArcGIS Pro to visualize the spatial patterns

Example Output – PAWNEE County:

Risk_Level	Length (km)
High	251.25
Low	135.95
Moderate	8.53







Discussion and Conclusion

This project successfully demonstrates how automated geoprocessing using Python can streamline spatial flood risk analysis. The modular approach allows users to plug in any of the 20 counties and receive immediate outputs, both for analysis and visualization. One challenge was ensuring data consistency across sources (e.g., CRS mismatch), and some fields needed to be truncated for shapefile export due to format limits. These issues were resolved through standardization and post-processing cleanup.

Future improvements could include:
- Dynamically setting the buffer distance
- Adding additional flood sources (e.g., dam failure)
- Exporting summary stats to a CSV or PDF
- Incorporating rainfall or DEM thresholds in risk classification

References

FEMA. (n.d.). National Flood Hazard Layer. https://www.fema.gov
NOAA. (n.d.). Precipitation Frequency Data Server (PFDS). https://hdsc.nws.noaa.gov
U.S. Census Bureau. (n.d.). TIGER/Line Shapefiles. https://www.census.gov
USGS. (n.d.). 3DEP DEM Data. https://www.usgs.gov